Photocouplers Infrared LED & Photo IC

# TLX9310

## 1. Applications

- Automotive
- Battery Management System (BMS)

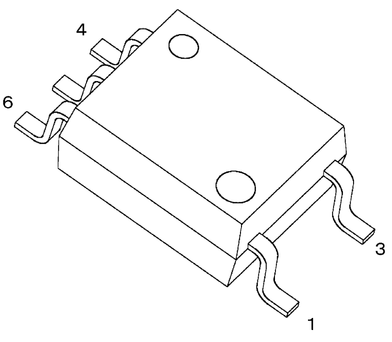
## 2. General

The Toshiba TLX9310 consists of a high-output an infrared LED coupled with a high-speed photo-diode-transistor chip. It is housed in the SO6 package. This photocoupler guarantees operation at up to 105 °C and on supplies from 2.7 V to 5.5 V. Since TLX9310 has guaranteed 0.3 mA low supply current ($I_{DDL}$/$I_{DDH}$), and 1.0 mA ($T_{opr}$ = 105 °C) low threshold input current($I_{FHL}$), it contributes to energy saving of devices. It can drive directly from a microcomputer for a low input current.

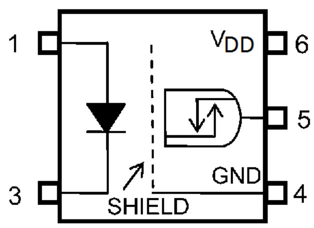
## 3. Features

(1) Buffer logic type (totem pole output)
(2) Package: SO6
(3) Operating temperature: -40 to 105 °C
(4) Supply voltage: 2.7 to 5.5 V
(5) Threshold input current: 1.0 mA (max)
(6) Supply current: 0.3 mA (max)
(7) Data transfer rate: 5 Mbps (typ.)
(8) Common-mode transient immunity: ±25 kV/μs (min)
(9) Isolation voltage: 3750 Vrms (min)
(10) AEC-Q101 qualified

## 4. Packaging and Pin Assignment

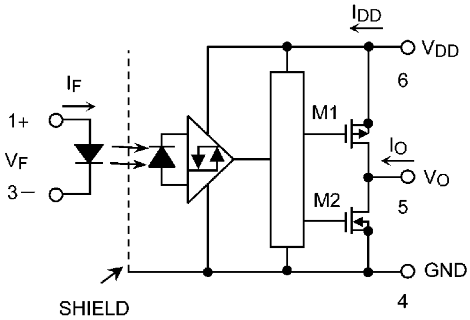



11-4L1S




1: Anode
3: Cathode
4: GND
5: $V_O$
6: $V_{DD}$

## 5. Internal Circuit (Note)




Note: A 0.1-μF bypass capacitor must be connected between pin 6 and pin 4.

## 6. Principle of Operation

### 6.1. Truth Table

| Input | LED | Output |
|---|---|---|
| H | ON | H |
| L | OFF | L |

### 6.2. Mechanical Parameters

| Characteristics | Min | Unit |
|---|---|---|
| Creepage distances | 5.0 | mm |
| Clearance | 5.0 | |
| Internal isolation thickness | — | |

## 7. Absolute Maximum Ratings (Note) (Unless otherwise specified, $T_a$ = 25 °C)

| | Characteristics | Symbol | Note | Rating | Unit |
|---|---|---|---|---|---|
| LED | Input forward current | $I_F$ | | 8 | mA |
| | Input forward current derating ($T_a \geq$ 85 °C) | $\Delta I_F/\Delta T_a$ | | -0.05 | mA/°C |
| | Input forward current (pulsed) | $I_{FP}$ | (Note 1) | 1 | A |
| | Input power dissipation | $P_D$ | | 20 | mW |
| | Input reverse voltage | $V_R$ | | 5 | V |
| Detector | Output current | $I_O$ | | 10 | mA |
| | Output voltage | $V_O$ | | 6 | V |
| | Supply voltage | $V_{DD}$ | | 6 | V |
| | Output power dissipation | $P_O$ | | 20 | mW |
| Common | Operating temperature | $T_{opr}$ | | -40 to 105 | °C |
| | Storage temperature | $T_{stg}$ | | -55 to 125 | °C |
| | Lead soldering temperature (10 s) | $T_{sol}$ | | 260 | °C |
| | Isolation voltage (AC, 60 s, R.H. ≤ 60 %) | $BV_S$ | (Note 2) | 3750 | Vrms |

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: Pulse width (PW) ≤ 1 μs, 300 pps

Note 2: This device is considered as a two-terminal device: Pins 1 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

## 8. Recommended Operating Conditions (Note)

| Characteristics | Symbol | Note | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | | 2.7 | 3.0 to 5.0 | 5.5 | V |
| Operating temperature | $T_{opr}$ | | -40 | — | 105 | ℃ |

Note: The recommended operating conditions are given as a design guide necessary to obtain the intended performance of the device. Each parameter is an independent value. When creating a system design using this device, the electrical characteristics specified in this data sheet should also be considered.

Note: A ceramic capacitor (0.1 μF) should be connected between pin 6 ($V_{DD}$) and pin 4 (GND) to stabilize the operation of a high-gain linear amplifier. Otherwise, this photocoupler may not switch properly. The bypass capacitor should be placed within 1 cm of each pin.

Note: If the rising slope of the supply voltage ($V_{DD}$) for the detector is steep, stable operation of the internal circuits cannot be guaranteed.
Be sure to set 3.0 V/μs or less for a rising slope of the $V_{DD}$.

## 9. Electrical Characteristics (Note) (Unless otherwise specified, $T_a$ = -40 to 105 ℃, $V_{DD}$ = 2.7 to 5.5 V)

| Characteristics | Symbol | Test Circuit | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Input forward voltage | $V_F$ | | $I_F$ = 2 mA, $T_a$ = 25 ℃ | 1.4 | 1.55 | 1.7 | V |
| | | | $I_F$ = 2 mA | 1.2 | — | 1.9 | |
| Input reverse current | $I_R$ | | $V_R$ = 5 V, $T_a$ = 25 ℃ | — | — | 10 | μA |
| Input capacitance | $C_t$ | | V = 0 V, f = 1 MHz , $T_a$ = 25 ℃ | — | 20 | — | pF |
| Low-level output voltage | $V_{OL}$ | Fig. 12.1 | $I_F$ = 0 mA, $I_O$ = 20 μA | — | — | 0.1 | V |
| | | | $I_F$ = 0 mA, $I_O$ = 3.2 mA | — | — | 0.4 | |
| High-level output voltage | $V_{OH}$ | Fig. 12.2 | $I_F$ = 2 mA, $I_O$ = -20 μA | $V_{DD}$-0.1 | — | — | V |
| | | | $I_F$ = 2 mA, $I_O$ = -3.2 mA | $V_{DD}$-1.0 | — | — | |
| Low-level supply current | $I_{DDL}$ | Fig. 12.3 | $I_F$ = 0 mA | — | — | 0.3 | mA |
| High-level supply current | $I_{DDH}$ | Fig. 12.4 | $I_F$ = 2 mA | — | — | 0.3 | mA |
| Threshold input current (L/H) | $I_{FLH}$ | | $I_O$ = -3.2 mA, $V_O$ > 2.4 V | — | — | 1.0 | mA |

Note: All typical values are at $V_{DD}$ = 5 V, $T_a$ = 25 ℃, unless otherwise noted.

## 10. Isolation Characteristics (Unless otherwise specified, $T_a$ = 25 ℃)

| Characteristics | Symbol | Note | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Total capacitance (input to output) | $C_S$ | (Note 1) | $V_S$ = 0 V, f = 1 MHz | — | 0.8 | — | pF |
| Isolation resistance | $R_S$ | (Note 1) | $V_S$ = 500 V, R.H. ≤ 60 % | $10^{12}$ | $10^{14}$ | — | Ω |
| Isolation voltage | $BV_S$ | (Note 1) | AC, 60 s | 3750 | — | — | Vrms |

Note 1: This device is considered as a two-terminal device: Pins 1 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

## 11. Switching Characteristics (Note) (Unless otherwise specified, $T_a$ = -40 to 105 °C, $V_{DD}$ = 2.7 to 5.5 V)

| Characteristics | Symbol | Note | Test Circuit | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Propagation delay time (L/H) | $t_{pLH}$ | (Note 1) | Fig.12.5 | $V_{IN}$ = 3.3 V, $R_T$ = 820 Ω | — | — | 250 | ns |
| Propagation delay time (H/L) | $t_{pHL}$ | | | | — | — | 250 | |
| Pulse width distortion | $\|t_{pHL}-t_{pLH}\|$ | | | | — | — | 50 | |
| Propagation delay skew (device to device) | $t_{psk}$ | (Note 1), (Note 2) | | | — | — | 65 | |
| Propagation delay time (L/H) | $t_{pLH}$ | (Note 1) | Fig.12.5 | $V_{IN}$ = 5 V, $R_T$ = 1.6 kΩ | — | — | 250 | ns |
| Propagation delay time (H/L) | $t_{pHL}$ | | | | — | — | 250 | |
| Pulse width distortion | $\|t_{pHL}-t_{pLH}\|$ | | | | — | — | 50 | |
| Propagation delay skew (device to device) | $t_{psk}$ | (Note 1), (Note 2) | | | — | — | 65 | |
| Rise time | $t_r$ | (Note 1) | Fig.12.5 | $V_{IN}$ = 0 → 3.3 V, $R_T$ = 820 Ω, $V_{DD}$ = 5 V | — | 11 | — | ns |
| Fall time | $t_f$ | | | $V_{IN}$ = 3.3 → 0 V, $R_T$ = 820 Ω, $V_{DD}$ = 5 V | — | 13 | — | |
| High-level common-mode transient immunity | $CM_H$ | | Fig.12.6 | $V_{IN}$ = 3.3 V/5 V, $V_{DD}$ = 2.7 V/5 V, $V_{CM}$ = 1000 $V_{p-p}$, $T_a$ = 25 °C | ±25 | ±40 | — | kV/µs |
| Low-level common-mode transient immunity | $CM_L$ | | | | | | | |

Note: All typical values are at $V_{DD}$ = 5 V, $T_a$ = 25 °C, unless otherwise noted.

Note: Recommendation input resistance conditions

- $V_{IN}$ = 3.3 V: $R_1$ = $R_2$ = 430 Ω
- $V_{IN}$ = 5 V: $R_1$ = $R_2$ = 820 Ω

Note 1: f = 250 kHz, duty = 50 %, input current $t_r$ = $t_f$ = 5 ns, $C_L$ is less than 15 pF which includes probe and stray wiring capacitance.

Note 2: The propagation delay skew, $t_{psk}$, is equal to the magnitude of the worst-case difference in $t_{pHL}$ and/or $t_{pLH}$ that will be seen between units at the same given conditions (supply voltage, input current, temperature, etc.).

## 12. Test Circuits

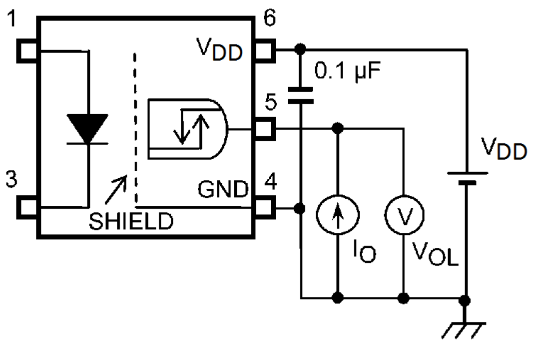



Fig. 12.1 $V_{OL}$ Test Circuit

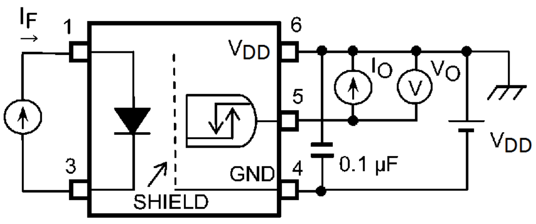



Fig. 12.2 $V_{OH}$ Test Circuit

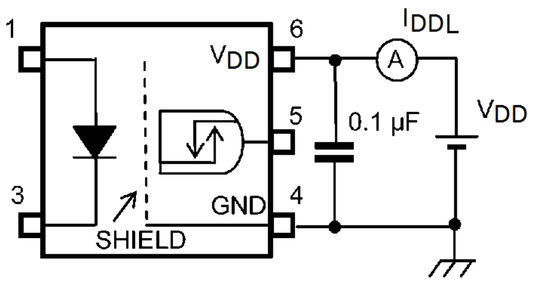



Fig. 12.3 $I_{DDL}$ Test Circuit

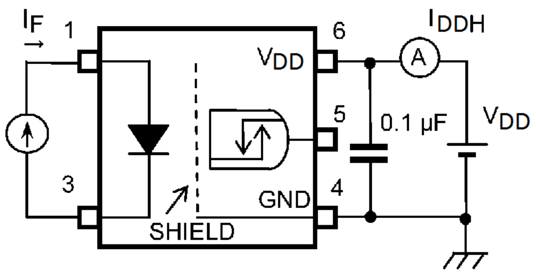
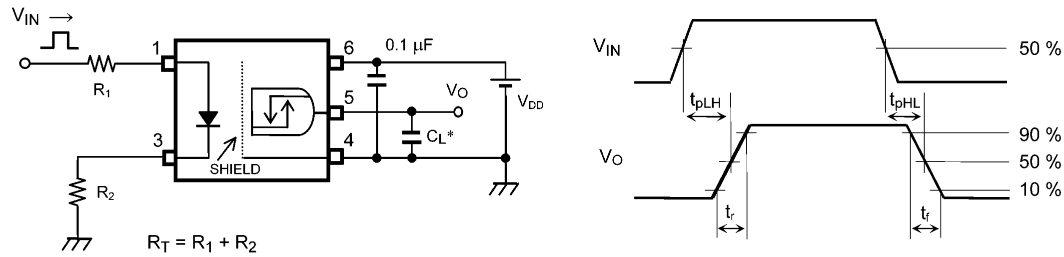



Fig. 12.4 $I_{DDH}$ Test Circuit

$V_{IN}$ = 3.3 V / 5 V (P.G.)
(f = 250 kHz, duty = 50 %, less than $t_r = t_f$ = 5 ns)




$R_T = R_1 + R_2$
P.G. : Pulse generator
*$C_L$ is less than 15 pF which includes probe and stray wiring capacitance.

Fig. 12.5 Switching Time Test Circuit and Waveform

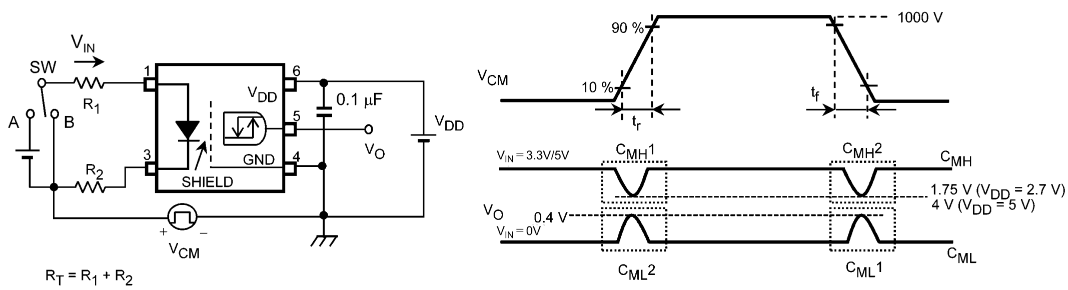
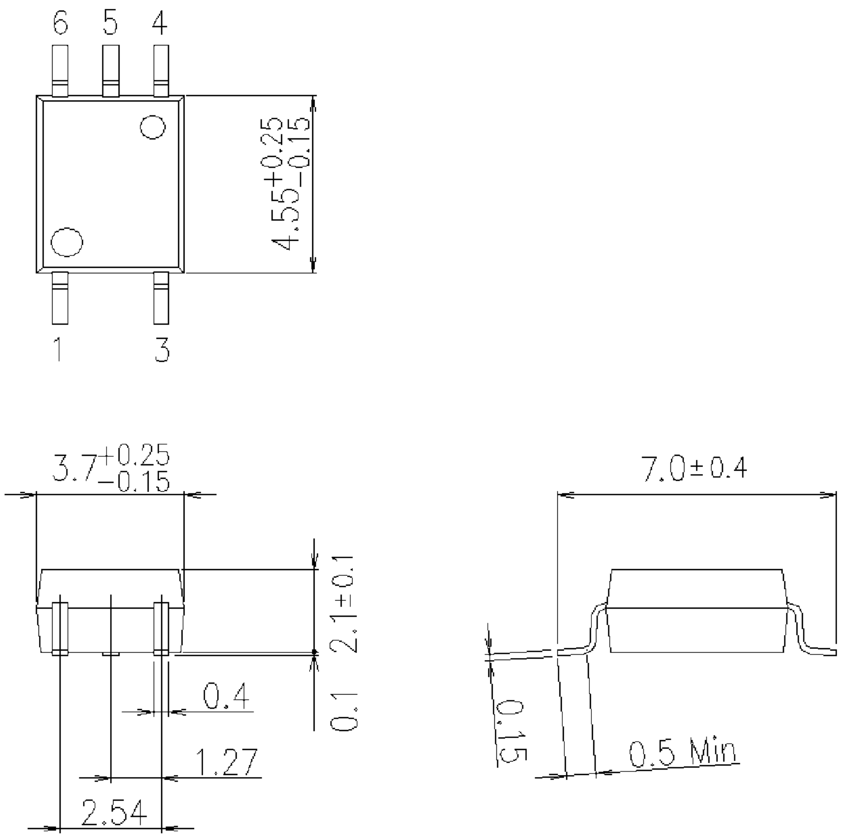



Fig. 12.6 Common-Mode Transient Immunity Test Circuit and Waveform

## Package Dimensions

Unit: mm




Weight: 0.08 g (typ.)

| Package Name(s) |
|---|
| TOSHIBA: 11-4L1S |

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